Developing a Framework of Possible Factors that Affect Water Quality in Basin-fill Aquifers of the Southwestern United States

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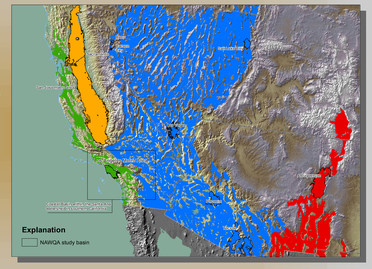
Ground water is an important source of water to many cities and agricultural communities in the basins of the arid-semiarid southwestern United States and the quality of this resource, now and in the future, is of concern.

The U.S. Geological Survey's National Water-Quality Assessment Program (NAWQA) is studying the water quality of the basin-fill aquifers in the Southwest and the factors that affect water quality across the region. The study described here began this year (2006) and is planned to be part of a long-term project to better understand ground-water quality in the Southwest.

Principal aquifers used in regional analysis

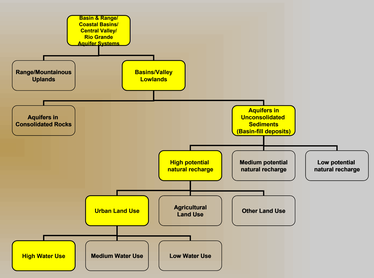
- Basin and Range basin-fill aquifers in Nevada, Utah, Arizona, and California
- Rio Grande aquifer system in New Mexico and Colorado
- Coastal Basins in California
- Central Valley aquifer system in California



These principal aquifers consist primarily of unconsolidated sediment, have similar land-and water-use practices (although to varying degrees), and face many of the same water-quality issues.

Framework of factors that may affect water quality in the Southwest basin-fill aquifers

A framework of susceptibility and vulnerability factors that may affect ground-water quality in the deeper parts of basin-fill aquifers of the southwestern United States is being developed as part of this study. This framework of factors will be used to assess similarities and differences in ground-water quality in the region. It is based on the physical characteristics of the basins, such as climate and topography; and the vulnerability of the aquifers to contamination, which is related to population density and type of land use.

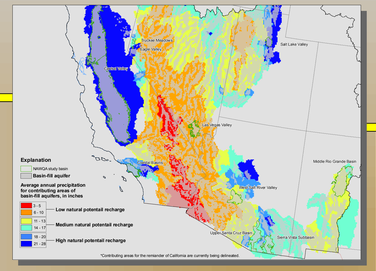


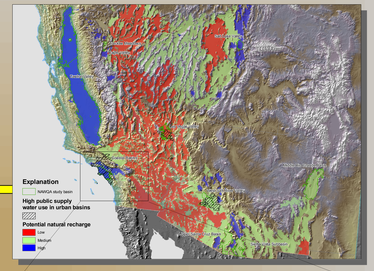
Factors shown in yellow are included in the example shown to the right.

An example of how the susceptibility and vulnerability factors will be used

Aquifers in Unconsolidated Sediments (Basin-fill deposits)

High potential natural recharge

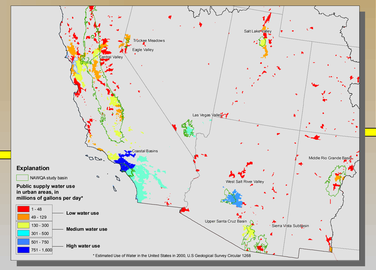


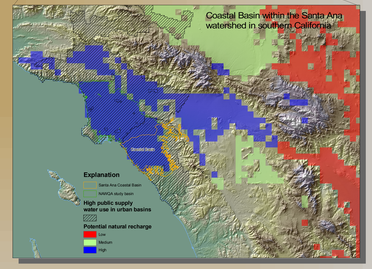


Each basin in the Southwest has a unique set of relations among the susceptibility and vulnerability factors we've chosen to study. Once identified, these relations can be used in further assessments of water quality.

Urban land use

High water use





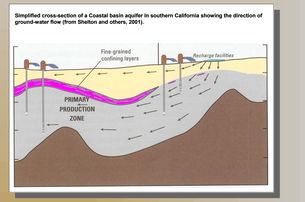
The relation among framework factors, as shown on the map above, indicates where areas of high, medium, and low potential natural recharge to basin-fill aquifers intersects urban areas with high public-supply water use. This relation is shown in more detail for the Coastal Basin in Southern California.

An example of how water quality is related to factors

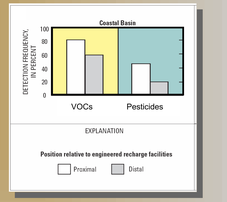
The occurrence and distribution of volatile organic compounds (VOCs) and pesticides in the Coastal Basin of southern California was evaluated in relation to two types of explanatory factors:

Hydrogeologic characteristics
- Aquifer confinement (unconfined or confined)
- Proximity to engineered recharge facilities

Land-use factors
- Percentage of urban and agricultural land
- Population density



VOCs and pesticides were detected more frequently in wells proximal to engineered recharge facilities than in distal wells. These compounds were also detected more frequently in the unconfined area then in the confined area of the basin. Land use within 500 meters of wells was not an explanatory factor for the occurrence of VOCs and pesticides in Coastal Basin ground water (Hamlin and others, 2005).



Future work: Relating water quality to potential factors

- Water-quality data sets from the S outhwest will be compiled to statistically test the relation between selected constituent concentration or detection probabilities to framework variables.
- Water-quality data and the framework will be used to assess hypot heses explaining water quality in the aquifers.
- Where water quality is not adequately modeled by the framework, more study will be needed to determine which factors affect the ground-water quality.

References

Hamlin, Scott N., Belitz, Kenneth, and Johnson, Tyler, 2005. Occurrence and distribution of volatile organic compounds and pesticides in ground water in relation to hydrogeologic characteristics and land use in the Santa Ana Basin, southern California: U.S. Geological Survey Scientific Investigations Report 2005 -5032.

Shelton, Jennifer L., Burow, Karen R., Belitz, Kenneth, Dubrovsky, Neil M., Land, Michael, and Gronberg, JoAnn, 2001, Low-level volatile organic compounds in active public supply wells as ground-water tracers in the Los Angeles physiographic basin, California, 2000: U.S. Geological Survey Water -Resources Investigations Report 01 -4188.